UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCR-2017-6715

November 30, 2017

Robert Clarke
Fisheries Program Supervisor
U.S. Fish and Wildlife Service
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations for the proposed Delta Research Station project

Dear Mr. Clarke:

Thank you for your February 14, 2017, letter requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the proposed Estuarine Research Station and Fish Technology Center (collectively referred to as the Delta Research Station project) located in Solano County, California. The U.S. Fish and Wildlife Service (USFWS) has determined that the proposed Delta Research Station project may affect, but would not be likely to adversely affect the endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened California Central Valley steelhead (*O. mykiss*), threatened Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*), or any of their respective designated critical habitats. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)) for this action.

Based on the best available scientific and commercial information, this biological opinion concludes that the proposed Delta Research Station project is not likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, or any of their designated critical habitats, including that of the Southern distinct population segment of North American green sturgeon. In addition, NMFS has further concluded that the proposed Delta Research Station project is not likely to jeopardize the continued existence of the Southern distinct population segment of North American green sturgeon. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take associated with the proposed Delta Research Station project.

The enclosed EFH consultation also transmits NMFS' EFH conservation recommendations for Chinook salmon (*O. tshawytscha*), as required by the MSA as amended (16 U.S.C. 1801 et seq.). This document concludes that the proposed Delta Research Station project will adversely affect the EFH of Chinook salmon in the action area and adopts some of the ESA conservation recommendations of the biological opinion as the EFH conservation recommendations.

Section 305(b)(4)(B) of the MSA requires the USFWS to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of the measures adopted by the USFWS for avoiding, minimizing, or mitigating the impact of the activity on EFH (50 CFR 600.920 (j)). In the case of a response that is inconsistent with our recommendations, the USFWS must explain its reasons for not following the recommendations, including scientific justification for any disagreements with NMFS over the anticipated effects of the proposed Delta Research Station project and the measures needed to avoid, minimize, or mitigate such effects. If unable to complete a final response within 30 days, the USFWS should provide an interim written response within 30 days before submitting its final response.

Please contact Doug Hampton at the California Central Valley Office located in Sacramento, California at (916) 930-3610, or by email at Douglas.Hampton@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Maria Rea

for Barry A. Thom
Regional Administrator

Enclosure

cc: California Central Valley Office
Division Chron File: ARN #151422-WCR2017-SA0032

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Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations

Delta Research Station Project

NMFS Consultation Number: WCR-2017-6715

Action Agency: U.S. Fish and Wildlife Service

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	No		No	
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	No		No	
California Central Valley steelhead (*O. mykiss*)	Threatened	No		No	
Southern distinct population segment of North American Green Sturgeon (*Acipenser medirostis*)	Threatened	Yes	No	No	

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Maria Rea

for Barry A. Thom
Regional Administrator

Date: November 30, 2017

INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*.) and implementing regulations at 50 CFR 600.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts) under Consultation Number *WCR-2017-6715*. A complete record of this consultation is on file at the California Central Valley Office located in Sacramento, California.

1.2 Consultation History

- January 8, 2015 – NMFS attended the United States Army Corps of Engineers pre-application meeting for the Delta Research Station project (DRS).

- October 7, 2015 – NMFS attended a meeting with the California Department of Water Resources (DWR), the United States Fish and Wildlife Service (USFWS), and their consultant Horizon Water and Environment, LLC (Horizon) to discuss the project description and scope of the analysis prepared for the biological assessment (BA).

- December 8, 2015 –NMFS sent a letter to DWR providing comments on the draft Environmental Impact Report/Environmental Impact Statement prepared in support of the proposed DRS.

- January 18, 2016 – NMFS received a draft BA for the Estuarine Research Station from Horizon.

- February 14, 2017 – NMFS received two separate requests from the USFWS to initiate formal section 7 consultation on both the Estuarine Research Station and Fish Technology Center, with enclosed final BAs.

- July 14, 2017 – NMFS received an email from the USFWS, forwarding responses provided by Horizon to NMFS' requests for additional information.

- August 23, 2017 – NMFS received an email from Horizon providing additional supplemental information requested by NMFS. On this date, NMFS determined that it had received all of the information necessary to initiate formal section 7 consultation on the proposed DRS.

1.3 Proposed Federal Action

"Action" within the context of the ESA means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Similarly, the definition of a Federal action pursuant to the MSA means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal agency (50 CFR 600.910).

The USFWS intends to construct and operate the proposed DRS in order to enhance interagency coordination and collaboration for the consolidation and implementation of several Interagency Ecological Program (IEP) programs, including ongoing research and monitoring activities, being concurrently carried out throughout the San Francisco Bay and Sacramento-San Joaquin River Delta (Bay-Delta). Currently, federal and state agency staff working on similar Bay-Delta issues are distributed among several different locations that are often remote from the Bay-Delta. Construction and operation of the DRS is expected to reduce travel costs and improve research and monitoring activity coordination and efficiency. In its entirety, the DRS will be comprised of two main research facilities, the Estuarine Research Station (ERS) and the Fish Technology Center (FTC). Both of these facilities will be centrally co-located within the Bay-Delta at the western edge of the Delta on the western bank of the Sacramento River on the Rio Vista Army Reserve Center (RVARC) site. The RVARC site lies south of the Yolo Bypass and Cache Slough Complex approximately 13 miles north of the San Joaquin River confluence in the City of Rio Vista in Solano County, California (Figures 1 and 2).

The RVARC is not currently in use, but most of the existing buildings and structures on the RVARC's lower terrace and eastern portion of the site include deteriorated warehouses, barracks, a vehicle maintenance shop, a water tower, and other structures, which will remain in place. A Pacific Gas and Electric Company (PG&E) gas pipeline easement crosses east-west through the northern portion of the site. Land uses immediately adjacent to the RVARC site include a private marina to the north, a U.S. Coast Guard station to the south, agricultural land across Beach Drive to the west, and commercial and recreational uses on the Sacramento River to the east. A few single-family homes are also located on the west side of Beach Drive near the northwest and southwest corners of the site. A paved path follows the western border of the site along Beach Drive.

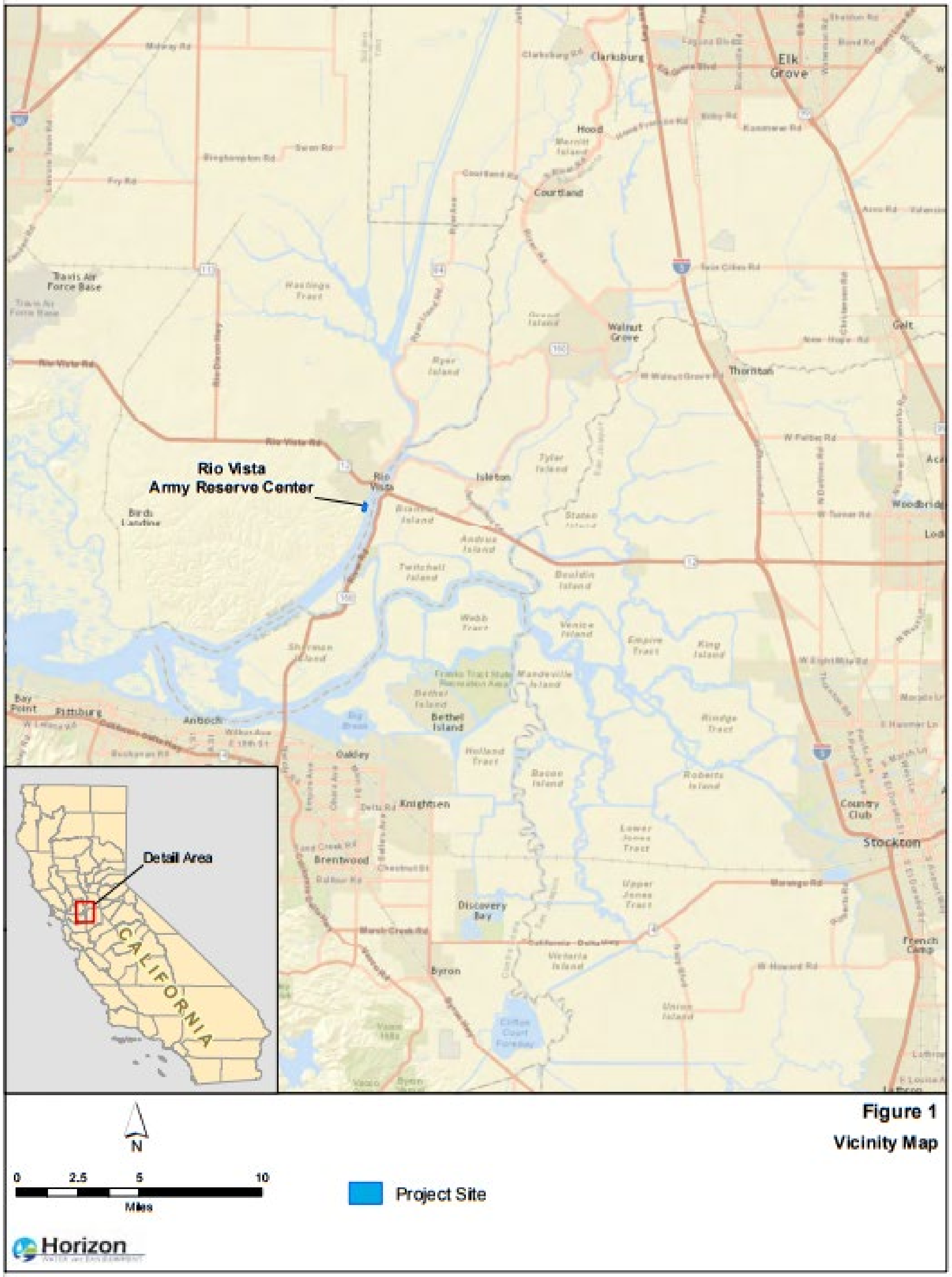

Figure 1. Vicinity map that includes the location of the proposed Delta Research Station in the Sacramento-San Joaquin Delta in the City of Rio Vista in Solano County, California (map taken from the ERS BA).

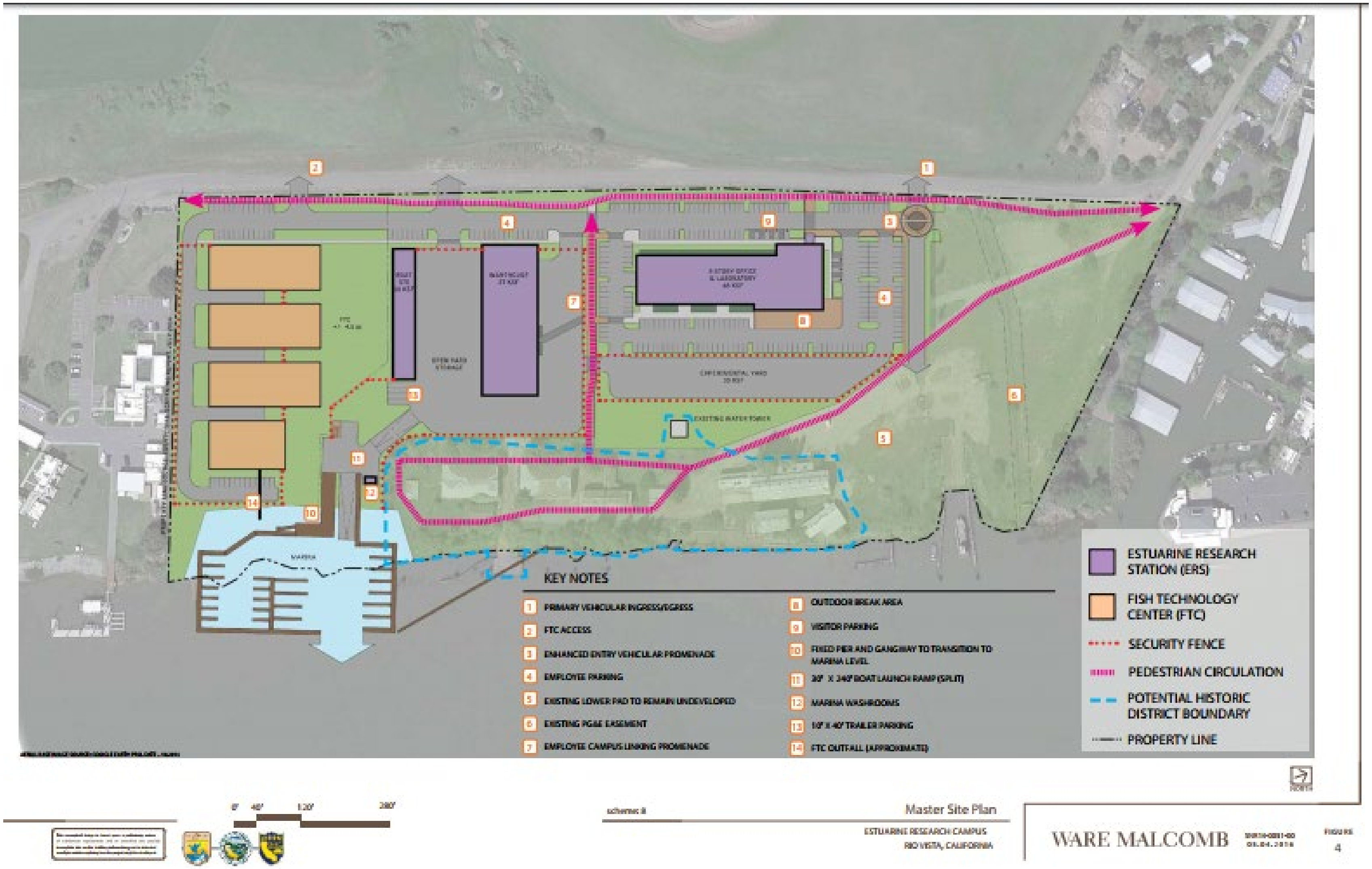

Figure 2. Proposed layout for the DRS on the RVARC site (figure taken from the ERS BA).

The DRS will have two entry points from Beach Drive: one near the southern end and another at the northern end of the RVARC. Paved internal roadways will be constructed to provide circulation and connectivity among the buildings. A promenade will also be established between the northern side of the FTC buildings and a planned boat launch, enabling pedestrians to walk from the visitor parking area towards the shoreline. Designated employee, visitor, and secured state/federal agency parking will be provided throughout the site with most of the employee parking clustered near Beach Drive. Because construction of the two entry points will overlap with the existing path along Beach Drive, portions of this path will be repaved. Public access will be allowed through some portions of the site while other portions of the site will be secured and open to employees only. In the event that the City of Rio Vista decides to develop a trail along the site's waterfront (as envisioned in the Rio Vista Redevelopment Plan), pedestrians could access the shoreline near the boat launch.

The ERS will consolidate existing IEP programs currently located throughout the Bay-Delta, whereas the FTC will house a new program to develop and apply captive propagation technologies in support of population restoration.

The specific objectives of the ERS are to:

- establish a research station in a central location within the Bay-Delta to facilitate conducting monitoring and research;
- provide facilities to conduct monitoring and research on the Bay-Delta's aquatic resources; and
- co-locate the research station with a facility capable of studying fish in captivity (i.e., the FTC).

The specific objectives of the FTC are to:

- develop captive propagation technologies for the Bay-Delta's rare fish species,
- test and refine the captive propagation techniques;
- locate the facility where suitable water quality and quantity are available, and where ability to discharge wastewater is available, given the facility's various functions and operations; and
- co-locate the FTC with a facility conducting conservation research on Bay-Delta rare fish species (i.e., the ERS).

New facility construction for the DRS on the RVARC site includes FTC facilities, including an effluent treatment facility and sedimentation basins which will be clustered at the western end of the property, and the ERS's two-story office building, laboratory building, dry-dock boat storage building, open dry-dock boat storage area, shop building, storage area, and open field experimental yard, which will be located on the upper terrace of the site. There are three separate FTC aquaculture and research buildings planned, which will be approximately 16,000 square feet each. Those buildings will contain separate aquaculture and research components, each for the study of an individual species, and laboratory space to support water quality, genetic, and fish health analyses. These buildings may also include archival storage space for tissue samples, such as fin clips and otoliths, taken from native fishes. The aquaculture and research buildings will be equipped with back-up generators to provide electricity in the event of a power outage. In addition to the aquaculture and research buildings, the FTC will have an auxiliary facility that may include office and administrative space, a maintenance (woodworking/metalworking) shop, a break room, locker room, visitor reception area, and restrooms. The FTC will also include some water and wastewater infrastructure including groundwater wells, a surface water intake, raw water treatment system, effluent treatment system, and a discharge outfall.

In addition to the new facility construction described above, the ERS facilities will also include the installation of a new marina in the Sacramento River, requiring excavation along the shoreline on the southeastern end of the site. A fixed pier and gangway will be constructed alongside a split boat launch that includes a vehicle turnaround area and connects with the open yard storage area. A small restroom facility will be installed near the boat launch, and to prevent floating debris from getting lodged under the marina docks, a debris deflector will be installed at the northern end of the marina. Construction of the new marina will first require the demolition and removal of 4,700 square feet of existing in-water structures, including a pier consisting of approximately 140 10-inch diameter creosote piles, five separate dolphins totaling 45 9-inch diameter creosote piles, and two trestles supported by 12 24-inch diameter and 5 12-inch diameter creosote piles. Following the removal of existing in-water structures, the new marina will require the use of an impact pile driver to install approximately 35 24-inch diameter concrete or epoxy coated steel piles to support 12,900 square feet of floating docks with a 4,600-square foot service pier. Finally, construction of the new marina will also involve the placement of roughly 2,000 cubic yards of rock slope protection over 14,000 square feet of the shoreline on the landward side of the marina to help absorb the energy of waves.

Site preparation for construction of the proposed DRS will involve demolition, clearing and grubbing, excavation, import and placement of fill, and compaction. More specifically, site preparation for the proposed DRS will require the demolition of three existing buildings: a hazardous materials storage building, administration/barracks building, and vehicle maintenance shop. It will also involve removal of one ship repair dock and moorings situated near the southern end of the RVARC site. Previous sampling of Sacramento River sediments near the RVARC did not find high concentrations of pollutants that would require remediation or pose an ecological or human health risk. The area of buildings proposed for removal totals approximately 8,160 square feet. Materials from buildings to be demolished will be salvaged and reused on-site to the extent feasible. Clearing and grubbing will be conducted with standard excavators, bulldozers, and other necessary equipment and hand labor. All demolished materials, debris, and non-hazardous waste will be transported to the Potrero Hills Landfill, approximately 18 miles west of the City of Rio Vista. Any hazardous waste encountered will be disposed of at appropriate hazardous waste facilities. The nearest landfill that accepts hazardous waste is located in Kettleman City, approximately 200 miles south of the City of Rio Vista.

Excavation is anticipated to extend approximately 4 to 6 feet below the ground surface in areas where buildings and structures will be located. If contaminated soils are present in the soils, construction activities could expose these contaminants. Although residual soil contamination has been documented at the RVARC site, the California Department of Toxic Substances Control granted closure status to the site, indicating that no further action to remediate the site is required. Based on that regulatory status, any remaining contaminant concentrations are not expected to pose an unacceptable risk to human health or ESA-listed species; however, the possibility remains that contaminated soil or groundwater could be encountered during construction. A Preconstruction Hazardous Materials Assessment and, as necessary, creation of a Soil and Groundwater Management Plan would be implemented to ensure that sediment and dewatered groundwater are sampled for hazardous pollutants and properly stored, transported, and disposed of if determined to be hazardous.

Most of the demolition, clearing, grubbing, excavation, and construction activities associated with the proposed DRS will occur on or over dry land and are not expected to result in any impacts to listed anadromous fish species or the aquatic habitat in the adjacent waters of the Sacramento River due to the implementation of protective best management practices, including the watering of roads, the development of and adherence to a Spill Prevention Control and Countermeasure plan, and the deployment of silt barriers or sediment fences between the terrestrial and aquatic environments, all of which are expected to sufficiently minimize potential air and water quality impacts to the point of being discountable or insignificant. The construction of the marina, however, will require substantial work in or over the water which will likely disturb bottom sediments and result in temporarily diminished water quality conditions that could negatively impact aquatic species and the overall function and quality of the habitat in general. This opinion, therefore, will focus solely on the potential effects associated with the construction, operation, and maintenance of the marina and any other components of the proposed DRS that are proposed to occur in, over, or immediately adjacent to the water.

Specifically, construction of the ERS marina and boat launch will initially require 40,200 cubic yards of excavation and/or dredging over 61,000 square feet. Dredged/excavated material will be transported off-site for disposal at an approved dredged material placement site or reused in upland areas on-site. In addition, it is estimated that between 7,000 and 11,000 cubic yards of sediment may need to be dredged every 10–15 years for marina maintenance. Following excavation, in-water pile driving will be conducted by an impact pile driver mounted on a barge and fitted with a wood cushioning block to partially attenuate the acoustic impacts associated with pile driving activity. The dock system will be fabricated off-site and delivered to the site overland by truck. A crane will then be used to offload the pre-constructed dock sections from the truck and place them on a material barge to be towed to the specific location for each section where they will be assembled and installed in their predetermined location.

Construction of the DRS will occur over a 24- to 30-month period, although the ERS and FTC facilities may be constructed at separate times. All in-water work, including the removal of existing structures and any pile driving or construction activities associated with the installation of new structures in or over the water, will be limited to the period from July 1 to November 1 each year. All pile driving activities are expected to occur within a period of 2-3 weeks during the July 1 to November 1 in-water work window. Construction activities will occur between the hours of 7:00 a.m. and 5:00 p.m. Monday through Friday, consistent with the City of Rio Vista noise regulations.

The FTC will include aquaculture facilities and an on-site effluent treatment system for process water used in these facilities. Water quality can be degraded as a result of discharges of process water from aquaculture facilities that might also contain food, drugs, waste, algae, parasites, soluble metabolites, disease microorganisms, and/or other chemicals, all of which have the potential to degrade aquatic habitat and water quality for salmonids and other taxa that are sensitive to water quality impairments (Camargo 1992, Sindilariu 2007). Impaired water quality has also been associated with an increased risk of fish diseases resulting from stress (Svobodova 1993). Aquaculture activities at the FTC will involve the use of a variety of fish feeds and chemicals to sustain fish growth and prevent diseases. In addition, aquaculture operations will generate metabolic waste from fish raised at the facility. The effluent treatment system for the aquaculture facility will capture and process this effluent through drum filters, an underground holding tank, and evaporation ponds before ultimately discharging the treated effluent directly into the Sacramento River at a rate of 2,500 to 5,000 gallons per minute. The effluent treatment system will be designed, maintained, and operated such that any and all effluent originating from the DRS meets Basin Plan standards and any required National Pollutant Discharge Elimination System permits. In addition, USFWS and/or its contractor will prepare and implement an operational and management plan to minimize water quality impacts and ensure compliance with applicable solid waste disposal regulations. Furthermore, the development of, implementation, and adherence to a Hazard Analysis and Critical Control Points plan will include methods designed to prevent the introduction of aquatic invasive species into the FTC, and operational practices to prevent the spread of aquatic invasive species within and outside of the facility should prevention efforts fail. FTC operations will also attempt to minimize the spread of aquatic invasive species by conducting quarterly sampling at intake structures, raceway head boxes, settling ponds, and any other areas of concern. If aquatic invasive species are detected during this sampling, specimens will be sent to the regional invasive-species scientist for identification. Lastly, domestic water used at the DRS will be discharged directly to the City of Rio Vista's sewer system, which will treat the effluent before discharge into the Sacramento River. As a result, such effluent will not be expected to degrade water quality.

In addition to the minimization and avoidance measures already described, the USFWS additionally plans to purchase 1.7 Delta smelt/longfin smelt conservation credits from the Liberty Island Conservation Bank located in Yolo County to offset impacts to tidally influenced aquatic habitat. Credits will be purchased prior to construction of the marina.

Under the FWCA, an action occurs whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license" (16 USC 662(a)).]

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interdependent or interrelated activities associated with the construction of the proposed Delta Research Station.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The USFWS determined that the proposed action is not likely to adversely affect Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), California Central Valley (CCV) steelhead (*O. mykiss*), Southern distinct population segment (sDPS) of North American green sturgeon (*Acipenser medirostris*), or any of their respective designated critical habitats. Based on the timing and location of the action taken, NMFS concurs with the determination that the proposed DRS is not likely to adversely affect either of the two Chinook salmon runs, CCV steelhead, or any of their designated critical habitats, including that for the sDPS green sturgeon. The rationale supporting our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (2.12). NMFS has independently determined, however, that sDPS green sturgeon could experience or be exposed to negative impacts as a result of the construction and operation of the proposed DRS, and therefore have the potential to be adversely affected by it. This opinion will focus on the analysis of effects to sDPS sturgeon in support of that conclusion.

2.1 Analytical Approach

This opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designations of critical habitat for each species use the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a RPA to the proposed action.

2.2 Rangewide Status of the Species

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also helps to inform the description of the species’ current “reproduction, numbers, or distribution” as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 Southern Distinct Population Segment (DPS) of North American Green Sturgeon (*Acipenser medirostris*)

- Listed as threatened on June 6, 2006 (71 FR 17757)

The Federally listed sDPS green sturgeon occur in the action area and may be affected by the proposed DRS.

2.2.1.1 Species Listing History

Green sturgeon (*Acipenser medirostris*) are a species of ancient fish, highly adapted to benthic environments, and very marine oriented entering freshwater mainly to spawn, but residing in bays, estuaries, and near coastal marine environments for the vast majority of their lifespan. They are known to be long lived; green sturgeon captured in Oregon have been age-estimated up to 52 years old using a fin-spine analysis (Farr and Kern 2005). They are iteroparous, meaning they can spawn multiple times within their lifespan. The details of their biology are described in the life history section of this document, and also in various literature sources such as Moyle (2002), (Adams et al. 2007), (Beamesderfer et al. 2007), and (Israel and Klimley 2008).

Green sturgeon are divided into two DPSs, a northern DPS and a southern DPS (sDPS), and while individuals from the two DPSs are visually indistinguishable and have significant geographical overlap, current information indicates that they do not interbreed, nor do they utilize the spawning areas of each other's natal rivers. In this opinion, we only address sDPS green sturgeon because of its status as a listed species under the ESA. The sDPS green sturgeon include those green sturgeon that spawn south of the Eel River, specifically within the Sacramento and Feather rivers and possibly also the Yuba River. In this opinion, we review the life history of sDPS green sturgeon, discuss population viability parameters, identify extinction risk, discuss critical habitat features and their conservation values, and we discuss the suite of factors affecting the species. When necessary to fill in knowledge gaps, we borrow information about white sturgeon (*A. transmontanus*) and other sturgeon species.

In June of 2001, NMFS received a petition to list green sturgeon under the ESA and to designate critical habitat. After completion of a status review (Adams et al. 2002), NMFS found that the species was comprised of two DPSs that qualify as species under the ESA, but that neither DPS warranted listing. In 2003 this "not warranted' decision was challenged in federal court, and NMFS was asked to reconsider available information, taking into account rapidly developing new information. NMFS (2005a) revised its "not warranted" decision and proposed to list the sDPS as "threatened." In its 2006 final decision to list sDPS green sturgeon as threatened, NMFS cited concentration of the only known spawning population into a single river (Sacramento River), loss of historical spawning habitat, mounting threats with regard to maintenance of habitat quality and quantity in the Delta and Sacramento River, and an indication of declining abundance based upon salvage data at the State and Federal salvage facilities (71 FR 17757). Since the original 2006 listing decision, new information has become available that reinforces the original reasons for listing and reaffirms NMFS concerns that sDPS green sturgeon face substantial threats challenging their recovery (NMFS 2015).

2.2.1.2 Green Sturgeon Life History

1. <u>Adult Migration and Spawning</u>

Green sturgeon reach sexual maturity between 15–17 years of age (Beamesderfer et al. 2007), and they typically spawn once every 2–5 years (average is 3.75 years, Mora unpublished data). Based on data from acoustic tags (Heublein et al. 2009), adult sDPS green sturgeon leave the ocean and enter San Francisco Bay from January to early May. Migration through the bay/Delta takes about 1 week and progress upstream is fairly rapid to their spawning sites. Green sturgeon spawn primarily in the Sacramento River, with most spawning activity concentrated in the mid-April to mid-June time period (Poytress et al. 2013). In 2011 spawning was confirmed in the Feather River by DWR, and suggested in the Yuba River (Bergman et al. 2011).

Various studies of spawning site characteristics (Poytress et al. 2011) agree that spawning sDPS green sturgeon typically favor deep, turbulent holes over 5 meters deep, featuring sandy, gravel, and cobble type substrates. Water depth may be negotiable, as spawning has been documented in depths as shallow as 2 meters (Poytress et al. 2011). However, substrate type is likely constrained as the interstices of the cobble and gravel catch and hold eggs, allowing them to incubate without being washed downstream. Flows need to be high enough to create the deep, turbulent habitat that green sturgeon favor for spawning. Successful egg development requires a water temperature range between 11°C and 19°C (52°F and 66°F). Larvae and juveniles appear to have broader temperature tolerances than eggs.

Poytress et al. (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008–2012 that identified a number of spawning locations. Green sturgeon fecundity is approximately 50,000–80,000 eggs per adult female (Van Eenennaam et al. 2001). Green sturgeon have the largest egg size of any sturgeon. The outside of the eggs are mildly adhesive and are denser than those of white sturgeon (Kynard et al. 2005, Van Eenennaam et al. 2009).

Post spawning adults have been observed to leave the system rapidly or to hold in deep pools and migrate downriver in winter after the first storms. Benson et al. (2007) conducted a study in which 49 adult green sturgeon were tagged with radio and/or sonic telemetry tags and tracked manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding. Following spawning, sDPS green sturgeon typically re-enter the ocean generally from November through January (with the onset of the first winter storms), with migration through the estuary lasting about a week.

2. Juvenile Migration

Larval green sturgeon hatch in the late spring or summer (peak in July) and progress downstream towards the Delta rearing into juveniles. It is unknown precisely when they enter the Delta or make the transition to life in the ocean, but based on age and growth studies of northern DPS green sturgeon (Nakamoto et al. 1995), juvenile green sturgeon become highly tolerant of salinity and may enter the ocean within their first year, or alternatively, they may rear for up to 2–3 years in the estuary before entering the ocean (Allen and Cech 2007, Allen et al. 2011). Ocean entry marks the transition from juvenile to sub-adult.

3. Egg and Larval Stages

Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15ºC (59ºF;(Van Eenennaam et al. 2001, Deng et al. 2002). Studies conducted at the University of California, Davis (UC Davis) by Van Eenennaam et al. (2005) indicated that an optimum range of water temperature for egg development ranged between 14ºC (57.2ºF) and

17.5ºC (62.6ºF). Temperatures over 23ºC (73.4ºF) resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5ºC (63.5ºF) and 22ºC (71.6ºF) resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14ºC (57.2ºF), hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so (Van Eenennaam et al. 2005). Further research is needed to identify the lower temperatures limits for eggs and larvae.

Information about larval sDPS green sturgeon in the wild is very limited. The USFWS conducts annual sampling for eggs and larvae in the mainstem Sacramento River. Larval green sturgeon appear in USFWS rotary screw traps at the RBDD from May through August (Poytress et al. 2010) and at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). USFWS data reveal some limited information about green sturgeon larvae, such as time and date of capture, and corresponding river conditions such as temperature and flow parameters.

Unfortunately, there is little information on diet, distribution, travel time through the river, and estuary rearing. Laboratory studies have provided some information about this initial life stage, but the relevance to fish in their natural habitat is unknown. Probably the most significant use of the USFWS data on larval green sturgeon has been to infer larval growth rates and correlations of these growth rates to temperature and flow conditions, making comparisons with larval green sturgeon growth rates in other river systems.

4. Juvenile Development and Outmigration

Young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River (CDFG 2002). Growth is rapid as juveniles move downstream and reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto et al. 1995). Juvenile sDPS green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and collected in sampling studies during all months of the year (CDFG 2002). The majority of juveniles that were captured in the Delta were between 200 and 500 mm indicating they were from 2 to 3 years of age based on age/growth studies from the Klamath River (Nakamoto et al. (1995). The lack of any juveniles smaller than approximately 200 mm in the Delta suggests that smaller individuals rear in the Sacramento River or its tributaries. Juvenile sDPS green sturgeon may hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard et al. (2005). Juvenile green sturgeon captured in the Delta by Radtke (1966) ranged in size from 200-580 mm, further supporting the hypothesis that juvenile green sturgeon enter the Delta after 10 months or at 200 mm in size. Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance from 15ºC (59º F) to 19ºC (66.2ºF) (Mayfield and Cech 2004).

Radtke (1966) inspected the stomach contents of juvenile green sturgeon (range: 200-580 mm) in the Delta and found food items to include mysid shrimp (*Neomysis awatschensis*), amphipods (*Corophium sp.*), and other unidentified shrimp. In the northern estuaries of Willapa Bay, Grays Harbor, and the Columbia River, green sturgeon have been found to feed on a diet consisting primarily of benthic prey and fish common to the estuary. For example, burrowing thalassinid shrimp (mostly *Neotrypaea californiensis*) were important food items for green sturgeon taken in Willapa Bay, Washington (Dumbauld et al. 2008).

5. Estuarine Rearing

There is a fair amount of variability (2 - 3 years) in the estimates of the time spent by juvenile green sturgeon in fresh or brackish water before making their first migration to sea. Nakamoto et al. (1995) found that green sturgeon on the Klamath River migrated to sea, on average by age 3 and no later than by age 4. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that green sturgeon juveniles may occupy fresh to brackish water at any age, but they gain the physiological ability to completely transition to saltwater at around 1.5 years of age (Allen and Cech 2007). In studying green sturgeon on the Klamath River, Allen et al. (2009) devised a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and analyzing the strontium to calcium ratios. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5-1.5 years and then move into seawater at ages 2.5-3.5 years.

6. Ocean Rearing

Once green sturgeon juveniles make their first entry into sea, they enter the sub-adult phase and spend a number of years migrating up and down the coast. Sub-adults mature in coastal marine environments and in bays and estuaries until approximately 9-17 years of age before returning to their natal freshwater river to spawn. An individual may spawn once every 3-5 years and live for 50 years or more. While they may enter river mouths and coastal bays throughout their years in the sub-adult phase, they do not return to their natal freshwater environments before they are mature.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley et al. 2011). Genetic studies on green sturgeon stocks indicate that the green sturgeon in the San Francisco Bay ecosystem belong exclusively to the sDPS (Israel et al. 2009). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay at all months of the year (Kelly et al. 2007, Heublein et al. 2009, Lindley et al. 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean, and why they aggregate episodically (Lindley et al. 2008, Lindley et al. 2011).

2.2.1.3 Green Sturgeon Viable Salmonid Population (VSP) Parameters

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a VSP. The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany et al. 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity. Although the VSP concept was developed for Pacific salmonids, the underlying parameters are general principles of conservation biology and can therefore be applied more broadly; here we adopt the VSP parameters for analyzing sDPS green sturgeon viability.

1. Abundance

In applying the VSP concept, abundance is examined at the population level, and therefore population size is perhaps a more appropriate term. Historically, abundance and population trends of sDPS green sturgeon has been inferred in two ways; first by analyzing salvage numbers at the CVP and SWP fish collection facilities (see below), and second, by incidental catch of green sturgeon by the CDFW's white sturgeon sampling/tagging program. Both methods of estimating sDPS green sturgeon abundance are problematic as biases in the data are evident. Only recently has more rigorous scientific inquiry begun with Israel and May (2010) and Mora (unpublished data).

A decrease in sDPS green sturgeon abundance has been inferred from the number of observations at the CVP and SWP fish collection facilities. These data should be interpreted with some caution as operations and practices at the facilities have changed over the years, which may additionally affect the salvage data. Despite the potential pitfalls of using salvage data to estimate abundance for sDPS green sturgeon, recent trends show what appears to be a very steep decline in abundance, and potentially great cause for concern.

Beginning in 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctoral thesis at UC Davis, Ethan Mora has been using acoustic telemetry to locate green sturgeon in the Sacramento River, and to derive an adult spawner abundance estimate. Preliminary results of these surveys estimate an average annual spawning run of 272 fish (Mora unpublished data). This estimate does not include the number of spawning adults in the lower Feather River where green sturgeon spawning was recently confirmed.

2. Productivity

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data from rotary screw traps set seasonally near the Red Bluff and GCID diversions. These data show enormous variance between years with a high count of 3,700 larval captured in 2011 (Poytress et al. 2012). In other years, larval counts were an order of magnitude lower. There is some concern that the Sacramento River may have temperature regimes too cold for optimal larval growth, or for optimal hatching success in the upper regions of the river (Poytress et al. 2013). In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events (NMFS 2010). It is unclear if the population is able to consistently replace itself or grow to greater abundance than levels currently observed. Other indicators of productivity, such as cohort replacement ratios, do not exist for sDPS green sturgeon. The long lifespan of the species and long age to maturity makes trend detection dependent upon data sets spanning decades, something that is currently lacking. Continuation of the acoustic telemetry work initiated on the Sacramento and Feather rivers (Mora et al. 2009, Seesholtz et al. 2014), as well as larval and juvenile studies carried out in the upper Sacramento River (Poytress et al. 2012) may eventually produce a more statistically robust analysis of productivity.

3. Spatial Structure

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During the late summer and early fall, subadults and non-spawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett et al. 1991, Moser and Lindley 2007).

Israel et al. (2009) found that green sturgeon within the Central Valley of California are sDPS green sturgeon. Acoustic tagging studies have shown that green sturgeon found within the San Francisco Bay estuary and further inland are exclusively sDPS green sturgeon.

In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and range up the Sacramento, Feather, and Yuba rivers. In the Yuba River, green sturgeon have been documented up to Daguerre Point Dam (Bergman et al. 2011). Migration past Daguerre Point Dam is not possible for green sturgeon, although potential spawning habitat upriver does exist. The same can be said about the Feather River where green sturgeon have been observed by DWR staff up to the Fish Barrier Dam. On the Sacramento River, Keswick Dam, located at RM 302, marks the highest point on the river accessible to green sturgeon, and it might be presumed that green sturgeon would utilize habitat up to this point. However, USFWS sampled for larvae in 2012 at RM 267 and at RM 292 and no larvae were caught at these locations; habitat usage could not be confirmed any further upriver than the confluence with Ink's Creek (RM 264), which was a confirmed spawning site in 2011 (Poytress et al. 2012). Adams et al. (2007) summarized information that suggests green sturgeon may have been distributed above the locations of present-day dams on the Sacramento and Feather rivers. Mora et al. (2009) analyzed and characterized known green sturgeon habitat and used that characterization to identify potential green sturgeon habitat within the Sacramento and San Joaquin river basins that now lies behind impassable dams. This study concludes that about 9 percent of historically available habitat is now blocked by impassible dams, but more importantly, this blocked habitat was of likely high quality for spawning.

Mora (unpublished data) revealed that green sturgeon spawning sites are concentrated in just a handful of locations. Mora found that in the Sacramento River just 3 sites accounted for over 50 percent of the green sturgeon documented in June of 2010, 2011, and 2012. This is a critical point with regards to the application of the spatial structure VSP parameter, which is largely concerned with the spawning habitat spatial structure. Given a high concentration of individuals into just a few spawning sites, extinction risk due to stochastic events would be expected to be increased.

Green sturgeon were historically documented in the lower San Joaquin River; (Radtke 1966) reported catching green sturgeon at the Santa Clara Shoals (which is near the confluence to the San Joaquin River and the Sacramento River) and to a much lesser extent, west of Stockton. However, there is no known modern usage of the San Joaquin River by green sturgeon. Anglers have reported catching green sturgeon at various locations within the San Joaquin River basin; however none of these reports have been verified and no photographic evidence has surfaced. Unless stronger evidence can be shown, it is currently believed that green sturgeon do not use the San Joaquin River or its tributaries.

In summary, current scientific understanding indicates that sDPS green sturgeon is composed of a single, independent population, which principally spawns in the mainstem Sacramento River, and also breeds opportunistically in the Feather River and possibly even the Yuba River. Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent extirpation from the San Joaquin River narrows the habitat usage by the species, offering fewer alternatives to impacts upon any portion of that habitat.

4. Diversity

Diversity, as defined in McElhany et al. (2000), includes genetic traits such as DNA sequence variation, and other traits that are influenced by both genetics and the environment, such as ocean behavior, age at maturity, and fecundity. Variation is important to the viability of a species for several reasons. First, it allows a species to utilize a wider array of environments than they could without it. Second, diversity protects a species from short term spatial and temporal changes in the environment by increasing the likelihood that at least some individuals will have traits that allow them to persist in spite of changing environmental conditions. Third, genetic diversity provides the raw material necessary for the species to have a chance to adapt to changing environmental conditions over the long term.

While it is recognized that diversity is crucial to the viability of a species in general, it is not well understood how well sDPS green sturgeon display these diversity traits and if there is sufficient diversity to buffer against long term extinction risk. In general, a larger number of populations and number of individuals within those populations should offer increased diversity and greater chance of long term viability. The diversity of sDPS green sturgeon is probably low given current abundance estimates. Also, because human alteration of the environment is so pervasive in the California Central Valley, basic diversity principles such as run timing and behavior are likely adversely influenced through mechanisms such as diminished springtime flow rates as water is impounded behind dams, to give but one example.

5. Summary

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (National Marine Fisheries Service 2010). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000). The best available scientific information indicates that the extinction risk facing sDPS green sturgeon is not negligible over a long term (~100 year) time horizon; therefore the sDPS is believed to be not viable. To support this statement, the PVA that was done for sDPS green sturgeon in relation to stranding events (Thomas et al. 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period, the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

The upper mainstem Sacramento River below Keswick Dam is the only area where consistent annual spawning by sDPS green sturgeon has been confirmed (i.e., by the presence of eggs and larvae), and where all life stages of the sDPS are supported (Poytress et al. 2013). Based on these kinds of telemetry data and supporting genetic analyses, NMFS has determined that only one population of sDPS green sturgeon currently exists (Israel et al. 2009. Lindley et al. 2011). In discussing winter-run Chinook salmon, Lindley et al. (2007) stated that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and when applied to sDPS green sturgeon, they face a high extinction risk. However, based on the best available information, NMFS has determined the extinction risk to be moderate (NMFS 2010).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their habitat needs.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for the purposes of this consultation includes that portion of the Sacramento River that lies adjacent to and immediately offshore from the RVARC site centered on or about 38° 8' 45" Latitude and 121° 41' 33" Longitude. The action area extends a distance of 1,848 meters in all directions, both up and down river and laterally across the entire width of the channel (approximately 686 meters, or 2,251 feet) where water levels are influenced by tributary inflows and tidal action. This distance is based on the expected extent of acoustic effects emanating from in-water pile driving activity. The RVARC site is located approximately 1 mile south of the Rio Vista Bridge in the City of Rio Vista, Solano County, California.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.4.1 Status of the Species within the Action Area

The action area functions primarily as a migratory corridor, but also provides some use as holding and rearing habitat, for sDPS green sturgeon.

2.4.1.1 Southern DPS of North American Green Sturgeon

The numbers of sDPS green sturgeon collected throughout the year at the SWP and CVP fish collection facilities, which are located in the South Delta and serve as surrogate for estimating fish presence and density in the vicinity of the action area, are considerably lower than for other species of fish monitored at the facilities. Based on the salvage records dating back to 1981, green sturgeon may be present during any month of the year, yet appear to be most prevalent during the months of July and August. The sizes of these fish range from 136 mm to 774 mm, and average 330 mm. The size range indicates that these are sub-adult fish rather than adult or larval/juvenile fish. Based on age and growth studies of northern DPS green sturgeon conducted by Nakamoto et al. (1995), juvenile sDPS green sturgeon are believed to utilize the Delta for rearing for a period of approximately 3 years. The proximity of the CVP and SWP fish collection facilities to the action area would indicate that sub-adult and juvenile green sturgeon have a strong potential to be present within the action area during construction of the proposed DRS, but that their population density would be low in these waters.

2.4.2 Factors Affecting the Species in the Action Area

The action area encompasses a small portion of the area utilized by sDPS green sturgeon. Many of the range-wide factors affecting this species are discussed in the *Status of the Species* section of this opinion, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the construction of the proposed DRS.

The magnitude and duration of peak flows during the winter and spring, which affects listed salmonids in the action area, are reduced by water impoundment in upstream reservoirs. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (i.e., levees) and low lying terraces under cultivation (i.e., orchards and row crops) in the natural floodplain along the basins' tributaries. Consequently, managed flows in the main stem of the rivers often truncate the peak of the flood hydrograph and extend the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize sediments and create natural riverine morphological features within the action area. Furthermore, the unimpeded river flow is severely reduced by the combined storage capacity of the different reservoirs located throughout the watershed. Very little of the natural hydrologic input is allowed to flow through the reservoirs to the valley floor sections of the tributaries leading to the Delta. Most is either stored or diverted for anthropogenic uses. Elevated flows on the valley floor are typically only seen in wet years or flood conditions, when the storage capacities of the numerous reservoirs are unable to contain all of the inflow from the watersheds above the reservoirs.

High water temperatures also limit habitat availability for listed salmonids in the Sacramento River and the lower portions of the tributaries feeding into it. High summer water temperatures in the lower portions of the river frequently exceed 72ºF (CDEC database), and create a thermal barrier to the migration of adult and juvenile salmonids.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic (SRA) habitat. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the cumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Armored embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in LWD.

The use of rock armoring limits recruitment of LWD (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place for extended periods to generate maximum values to fish and wildlife (USFWS 2000). Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows (USFWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

Point sources and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of the action area. The effects of these impacts are discussed in detail in the *Status of the Species and Critical Habitat* section. Environmental stresses as a result of low water quality can lower reproductive success and may account for low productivity rates in fish. Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (i.e., heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Central Valley watersheds (USFWS 1995). Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, water quality, NIS, *etc.*, are discussed in the *Status of the Species and Critical Habitat* section.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

2.5.1 Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify designated critical habitat (16 U.S.C. §1536). This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the establishment of a final rule (81 FR 7414; February 11, 2016) that amends the regulations governing section 7 consultations under the ESA to revise the definition of "destruction or adverse modification" of critical habitat in order to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This opinion assesses the effects of constructing the proposed DRS on the sDPS of North American green sturgeon.

In the *Description of the Proposed Action* section of this opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this opinion, NMFS provided an overview of the listed species that were likely to be adversely affected by construction of the proposed DRS.

NMFS uses a series of sequential activities and analyses to assess the effects of Federal actions on endangered and threatened species and designated critical habitat. The first analysis uses the identified action components and interrelated and interdependent actions that result from the action deconstruction to identify environmental stressors—the physical, chemical, or biotic aspects of the Federal action that are likely to have individual, interactive, or additive direct and indirect effects on the environment. As part of this step, NMFS identifies the spatial extent of both the action components and any potential stressors, recognizing that the spatial extent of the stressors may change with time. NMFS notes that the spatial extent of potential stressors may extend beyond the geographic area included in the project description (i.e., a project description of in-Delta operations may have effects that extend upstream; the spatial extent of those effects is traced as part of this analysis).

The next step in the series of analyses starts by identifying the threatened or endangered species or designated critical habitat that are likely to occur in the same space and at the same time as the potential stressors and their spatial extent. Then we estimate the nature of that co-occurrence to represent the individual exposure assessment. In this step, we identify the proportion of a population (or number of individuals when available) and age (or life stage) that are likely to be exposed to an action's effects, and the specific areas and PBFs of critical habitat that are likely to be affected.

Once we identify which listed resources (i.e., endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of the exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure. This represents the individual response analysis. The final steps of our series of analyses establish the risks those responses pose to listed resources. These steps represent our risk analysis. They are different for listed species and designated critical habitat, each of which are discussed further below.

NMFS generally approaches the jeopardy analysis in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed Federal action on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; and others). The available evidence is then used to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The basis of the destruction or adverse modification analysis is to evaluate whether the Federal action affects the quantity or quality of the PBFs in the designated critical habitat for a listed species and, especially in the case of unoccupied habitat, whether the Federal action has any impacts to the critical habitat itself. Specifically, NMFS will generally conclude that a Federal action is likely to destroy or adversely modify designated critical habitat if the action results in an alteration of the quantity or quality of the essential PBFs of designated critical habitat, or that precludes or significantly delays the capacity of that habitat to develop those features over time, and if the effect of the alteration is to appreciably diminish the value of critical habitat for the conservation of the species (81 FR 7214). NMFS bases critical habitat analysis on the affected areas and functions of critical habitat essential for the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality. If an area encompassed in a critical habitat designation is likely to be exposed to the direct or indirect consequences of the Federal action on the natural environment, NMFS asks if PBFs included in the designation that give the designated critical habitat value for the conservation of the species are likely to respond to that exposure. In particular, NMFS is concerned about responses that are sufficient to reduce the quantity or quality of those PBFs or capacity of that habitat to develop those features over time. To conduct this analysis, NMFS follows the basic exposure-response-risk analytical steps described above and applies a set of reasoning and decision-making questions designed to aid in this determination. These questions follow a similar logic path and hierarchical approach to the elements and areas within a critical habitat designation. Following that, NMFS must determine whether reductions in the value of critical habitat for the conservation of the species in the exposed area of critical habitat are likely to appreciably diminish the overall value of critical habitat for the conservation of the species. A Federal action may adversely affect critical habitat in an action area without appreciably diminishing the value of critical habitat for the conservation of the species.

2.5.1.1 Information Available for This Assessment

To conduct this assessment, NMFS examined information from a variety of sources including: detailed background information on the status of species and critical habitat that has been published in a number of documents including peer reviewed scientific journals, primary reference materials, government and non-government reports, the *Biological Assessment for the Fish Technology Center*, the *Biological Assessment for the Estuarine Research Station*, and supplemental supporting information and materials provided by the USFWS and its contractors to NMFS through email correspondence as they became available over the course of the consultation.

2.5.1.2 Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS must make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

Additional information from fish monitoring studies conducted by the USFWS and CDFW regarding the timing and density of listed anadromous fish species presence in the Sacramento River was incorporated into the calculations for risk assessment.

In assessing the impacts of anthropogenic noise on listed anadromous fish species, NMFS used the acoustic experimental data for several different species of fish where the data are available, including the hearing specialist fathead minnow (*Pimephales promelas*) and the hearing generalist, pink snapper (*Pagrus auratus*). Protective acoustic levels were then determined that were appropriate for fish in general, due to a lack of data specific to salmonids or sturgeon. In a recent review of available information on the effects of anthropogenic sound generated by construction activities on the west coast of North America, Hastings and Popper (2005) specifically cited the lack of salmonid data as a critical gap in the scientific record for evaluating noise impacts, and recommended increased and focused studies on this group of fish.

2.5.2 Assessment

Overall construction of the proposed DRS will occur over a period of 24 to 30 months, but all in-water construction activities will be limited to the period from July 1 to November 1 each year. Project impacts on listed sDPS green sturgeon are expected to include both direct impacts to fish present in the action area during the activities, and indirect impacts that may occur later in time or downstream, and negatively affect fish occurring throughout the action area at any time of the year. Direct negative effects are expected to result from the generation of anthropogenic noise in the aquatic environment, primarily as a result of pile driving activity that will occur over a period of up to 3 weeks between July 1 and November 1, as well as from other construction-related noises throughout the same period, including boat and barge traffic. Additional direct effects may also occur as a result of temporary increases in the levels of suspended sediment and concentrations of contaminants present in the water column following construction activities that disturb the channel bottom and/or near-shore habitat. Indirect effects may occur as a result of the permanent loss of riparian vegetation and shallow water habitat in the action area, but these are expected to be insignificant relative to the quality and extent of the surrounding habitat, and therefore unlikely to result in take of sDPS green sturgeon. Additionally, the removal of existing creosote piles from the action area is expected to result in beneficial indirect effects over time as well. A brief discussion of the nature of both the direct and indirect effects stemming from the proposed DRS, and how they might be expected to impact listed sDPS green sturgeon follows below.

2.5.2.1 Direct Effects

Acoustic impacts to fish result from driving piles into the riverbed with an impact hammer during support pile installation. The force of the hammer hitting a pile forms a sound wave that travels down the pile and causes the pile to resonate radially and longitudinally. Acoustic energy is formed as the walls of the pile expand and contract, forming a compression wave that moves through the pile. The outward movement of the pile wall sends a pressure wave propagating outward from the pile and through the riverbed and water column in all directions.

Because inconsistent mediums, such as water, will result in a higher rate of transmission loss, environmental factors such as water depth, water turbulence, air bubbles, and substrate consistency are important to consider when estimating the distance a compression wave will travel. A compression wave traveling through shallow water and substrates with variable consistencies (i.e., variable particle size class distribution) will attenuate more rapidly than compression waves traveling through a constant medium such as deep water or bedrock. As a compression wave moves away from the source, the wave length increases and intersects with the air/water interface. Once the compression wave contacts the air, it attenuates rapidly and does not return to the water column.

The effect of pile driving on free swimming fish depends on the duration, frequency (Hz), and pressure (dB) of the compression wave. Rasmussen (1967) found that immediate mortality of juvenile salmonids may occur at sound pressure levels exceeding 208 dB. Due to their size, adult green sturgeon can tolerate higher pressure levels and immediate mortality rates for adults are expected to be less than those experienced by juveniles (Hubbs and Rechnitzer 1952).

The startling of fish can also cause injury by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Injury is caused when disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Disruption of these behaviors may also result in the death of some individuals due to increased predation if fish are disoriented or concentrated in areas with high predator densities. Disruption of these behaviors may occur for specific periods from July 1 to November 1 during daylight hours when the pile driving hammer is operating. Lapses in pile driving activity, however, are fairly common throughout the day on similar projects because construction crews suspend hammer work for equipment maintenance, to shift from one pile to another, and to take breaks. These construction lapses, including daily breaks and nighttime non-working periods, as well as long periods when no pile driving is scheduled to occur, will allow fish to migrate through the action area and minimize the extent of injury that occurs to populations.

2.5.2.2 Indirect Effects

Construction of the new marina will first require the removal of existing structures in the water. Structures to be removed include the remnants of dilapidated docks, piers, and dolphins, including approximately 200 piles of varying sizes. The removal of piles from the river has the potential to stir up suspended sediments and contaminants from just below the surface of the channel bottom, although increases of contaminants and turbidity in the action area as a result of this activity are expected to be temporary with conditions reverting quickly back to baseline conditions within a matter of hours following the disturbance. Furthermore, most, if not all, of the piles to be removed are likely composed of creosote-treated wood due to the age of the structures. Creosote contains polycyclic aromatic hydrocarbons, which contain carcinogenic metabolic intermediates that can cause developmental toxicity following prolonged exposure, and creosote-treated wood exposed to water and tidal action has the capacity to continually leach these compounds into the aquatic environment for years. Removal of creosote piles from the aquatic environment is, therefore, considered to be generally beneficial to aquatic life, including listed anadromous fish and the habitats they occupy.

Site preparation ahead of construction will also require significant clearing and grubbing activity, which will remove approximately 0.48 acre of existing riparian vegetation from the shoreline adjacent to the river's bank. Riparian vegetation, specifically SRA habitat, provides overhead cover, resulting in shade and protection, slower flow velocities for adult and juvenile fish resting spots, as well as providing substrate for food production, such as aquatic and terrestrial invertebrates for listed anadromous fish species. The removal of riparian vegetation and replacement with marina structures or rock slope protection (riprap) will result in the permanent loss of this habitat feature, and can have the effect of increasing predation rates by eliminating protective cover and refugia, reducing food production and feeding rates for juveniles, and exposing fish to increased water temperatures in the Delta during the late spring and summer partially due to the loss of riparian shading, any of which may result in decreased overall survival. Increased water temperatures due to the loss of overwater shading may be partially offset, however, by the installation of the new in- and over- water structures associated with the marina. The presence of those structures does not, however, contribute to allochthonous or autochthonous food production in the aquatic environment and, therefore, has a limited beneficial effect that does not fully replace the functional ecological value of riparian vegetation.

As a result of the marina's construction, NMFS expects that approximately 0.98 acre of shallow water habitat and 0.48 acre of riparian vegetation will be permanently lost due to displacement by in-water structures and conversion to deep water habitat through dredging and site preparation activities, in general. As noted previously, however, the area to be effected occurs along the frontage of what is now the dilapidated remnants of a historically active wharf and, as such, represents habitat that is already relatively degraded. Therefore, NMFS does not expect the permanent loss of 0.98 acre of shallow water habitat and 0.48 acre of riparian vegetation to result in negative effects to green sturgeon migrating through, and/or rearing in, the Sacramento River.

As the operation of a marina necessarily involves the routine ingress, egress, and storage of boats in the area, it is possible that some indirect effects to listed species in the action area may also occur as a result of those activities. Boat motors have the potential to introduce metals, hydrocarbons, and other pollutants into the aquatic environment. These compounds can have a negative effect on the water quality for fish in the system, including affecting pH and DO levels. Hazardous metals from boat motors may include lead, cadmium, and mercury, and exhaust may be discharged from some types of boat motors into the water column containing nitrogen, phosphorus, and carbon dioxide. In addition, metals from painted boats can contain arsenic. Many of these pollutants settle out of the water column onto sediment on the bottom of the channel and have been associated with the impaired development and survival of fish and invertebrate eggs, larvae, and juveniles. In some instances, propeller action from motorboat traffic can disturb bottom sediments, increasing the relative amounts of turbidity and nutrients in the water column, and thereby decreasing water clarity. If there is an abundance of nutrients in the sediment, this could increase phytoplankton production, further impairing water clarity. Similarly, if toxins are present in the sediment, they could be resuspended in the water column and taken up by listed fish or their prey.

With increasing boat traffic, turbidity on rivers is known to increase across the width of the channel, which can also affect near-shore aquatic plants in shallow bank areas typically used for shelter by juvenile fish. Increased boat traffic may also negatively affect the amount and condition of rearing habitat and migratory corridors in the action area for salmonids and sturgeon by disturbing sediment and decreasing food and water quality. Safe passage through the action area might also be somewhat compromised for migrating fish as a result of increased boat traffic contributing to the possibility of more frequent encounters between fish and boats (i.e., vessel strikes, propeller entrainment). The action area is located within the waters of the deep water ship channel of the Sacramento River, however, and routinely experiences a high volume of boating and shipping traffic. NMFS expects that the relatively small comparative output from the proposed marina would not dramatically increase the amount of pollutants, turbidity, and nutrients to which listed anadromous fish might become exposed.

2.5.2.3 Exposure

Small numbers of sDPS green sturgeon are anticipated to be present throughout the action area during construction of the proposed DRS. Although information on the density of sDPS green sturgeon presence in the action area is not currently available, their continual but infrequent occurrence in sampling studies targeting other fish species indicates that they may be present throughout the year in the waters of the Delta, and thus vulnerable to both short-term and long-term negative effects associated with the Federal action. Recent telemetry data suggest that some partitioning of the habitat by life stage may occur on a very coarse scale within the Delta, however. Based on that data and the specific location of the action area within the Delta, for example, NMFS considers it unlikely that any sub-adult sDPS green sturgeon will be exposed to the effects of the action because that life stage of the species, as well as other non-spawning adults, rarely, if ever, encroach that far into the interior Delta beyond San Francisco, San Pablo, or Suisun bays. Regarding adult spawning migrations, sDPS green sturgeon begin to enter the outer bays during the months of February and March, migrating through the action area to reach their upstream spawning grounds in the Sacramento River by late July or early August.

Therefore, spawning adults migrating upstream to their spawning grounds will likely not be exposed to the direct effects of the action either, as most will have passed through the action area prior to the initiation of in-water construction activities on July 1. Data on green sturgeon distribution are extremely limited, however, and emigration appears to occur at different times of the year, with post-spawn adults being recorded exiting the Sacramento River to transit the Delta towards the ocean in both the fall (November to December) and summer (June to August) months (Heublein et al. 2009). CDFW catch data for adult green sturgeon show that they may be present in the Delta during any month of the year, just as it is assumed that juvenile green sturgeon may spend up to 3 or 4 years rearing in the Delta before entering the ocean, and would also be present in the Delta during every month of the year. The life stages of green sturgeon most likely to be exposed to the direct effects of the action are therefore post-spawn adults and rearing juveniles.

As mentioned earlier in this opinion, and as documented in the *"Not Likely to Adversely Affect" Determinations* section (2.12) below, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or CCV steelhead are not expected to be present in the action area during construction of the proposed DRS, and therefore, will not be exposed to the direct effects of the action. Individuals migrating between the Sacramento River and the ocean following construction of the proposed DRS do have the potential, however, to become temporarily exposed to the long-term indirect effects associated with altered habitat conditions during their passage through the action area.

2.6 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Non-Federal actions in the action area include ongoing agricultural activities and increased urbanization. Agricultural practices in the action area may negatively affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the rivers and streams that flow into the Delta. Unscreened agricultural diversions along the Sacramento and San Joaquin rivers and throughout the Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids and sturgeon by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid and sturgeon reproductive success and survival rates (Dubrovsky et al. 1998, Daughton 2003).

Increased urbanization and housing developments can impact habitat by altering watershed characteristics and changing both water use and stormwater runoff patterns. Increased urbanization is also expected to result in increased wave action and propeller wash in Delta waterways due to increased recreational boating activity. This will potentially degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments, thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This will result in reduced habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and sturgeon. Increased recreational boat operation in the Delta is also anticipated to result in elevated contamination from the operation of engines on powered watercraft entering the water bodies of the Delta.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 Effects on Listed Species

During construction of the proposed DRS, adverse impacts to green sturgeon stemming from the loss of riparian vegetation and periods of increased turbidity are expected to occur. These impacts may cause physiological stress to the extent that the normal behavior patterns (e.g., feeding, sheltering, and migration) of affected individuals may be disrupted. Overall, the changes in turbidity and suspended sediment associated with construction activities are expected to negatively affect migrating or rearing juvenile green sturgeon primarily by low-level, short-term alteration of habitat conditions, which may reduce feeding or increase predation rates on juveniles. The potential for the increase in suspended sediment to negatively affect emigrating post-spawn adult green sturgeon is unclear. However, because sturgeon are demersal fish closely associated with the bottom substrate, feed by taste and feel with their barbels, and even shovel up sediment with their snouts when searching for food, it is likely that they would be unaffected by the levels and duration of turbidity expected to be produced by the proposed Project. Potential impacts are expected to be sufficiently minimized by meeting Regional Water Quality Control Board water quality objectives, implementing "best management practices" for erosion control, and limiting the removal of riparian vegetation.

Pile driving activities are scheduled to occur for up to 3 weeks during daylight hours between July 1 and November 1. The elevated noise levels around the pile driving activities may cause temporary behavioral changes and/or loss or reduction of hearing in affected fish. Rearing juvenile and migrating post-spawn adult sDPS green sturgeon are expected to avoid the elevated noise of the pile driving operations by swimming around the area with the highest noise levels or holding outside of the high noise areas until the pile driving activities cease. There is a potential for these fish to suffer a temporary loss of hearing sensitivity at the expected noise levels generated by the pile drivers. Loss of hearing sensitivities in juvenile fish could expose them to higher risks of predation. Fish with impacted hearing capacities will have a lower ability to detect predators and may be unable to maintain position in the water column due to inner ear equilibrium factors.

Noise from pile driving may also cause startling and/or avoidance of habitat by fish in the immediate vicinity of the action area. The startling of fish can cause harm by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Disruption of these behaviors may occur for specific periods during daylight operation hours of the pile driving hammer. A cessation of pile driving activities each night is expected to provide a respite allowing fish to migrate through the action area and minimize the extent of impacts to the population.

2.7.2 Effects on Listed Species Likelihood of Survival and Recovery

Little is known about the migratory habits and patterns of either adult or juvenile green sturgeon in the Delta region. The extent and duration of juvenile rearing for individual sDPS green sturgeon in the Delta is unclear, ranging anywhere from several months up to 3-4 years, but NMFS believes that both juvenile and post-spawn adult green sturgeon could be found during any month of the year within the waters of the Delta. Therefore, both adult and juvenile green sturgeon have the potential to be negatively affected by exposure to temporarily elevated turbidity and acoustic effects from pile driving activity due to construction of the proposed DRS.

Due to the lack of population abundance information regarding sDPS green sturgeon, a variety of estimates must be utilized to determine the range of effects resulting from the incidental take of a small number of green sturgeon. Compared to the estimated population sizes suggested by the CDFW tagging efforts and past IEP sampling efforts, incidental take resulting from exposure to elevated levels of acoustic impacts and suspended sediments, migration delays, physical injury, and mortality of both adult and juvenile sDPS green sturgeon is expected to represent a relatively small proportion of the standing population in the Sacramento River watershed, and is not expected to appreciably reduce the likelihood of survival and recovery of the southern DPS of North American green sturgeon.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of southern DPS of North American green sturgeon. Furthermore, it is NMFS' biological opinion that the proposed action is not likely to destroy or adversely modify the designated critical habitats for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

NMFS anticipates incidental take of sDPS green sturgeon through construction-related impacts in the action area is reasonably certain to occur. Specifically, NMFS anticipates that juvenile and adult green sturgeon may be killed, injured, or harassed during construction activities.

Using the best available information, NMFS cannot specifically quantify the anticipated amount of incidental take of individual sDPS green sturgeon because of the variability and uncertainty associated with the response of listed species to the effects of the action, uncertainty with regard to the varying population size of the DPS, annual variations in the timing of spawning and migration, and individual habitat use within the action area. However, it is possible to designate ecological surrogates for the extent of incidental take anticipated to be caused by the proposed DRS, and to monitor those surrogates to determine the level of incidental take that is occurring. The most appropriate ecological surrogate for the extent of incidental take caused by the proposed DRS is the amount and duration of pile driving conducted during project construction.

2.9.2 Ecological Surrogates

- The analysis of the effects of the proposed DRS anticipates that the installation of approximately thirty-five 24-inch diameter concrete or epoxy coated steel piles will require the use of an impact pile driving hammer operating for approximately 3 weeks between July 1 and November 1 during daylight hours resulting in acoustic effects exceeding 150 decibels (dB) out to a distance of 1,848 meters (6,063 feet) from the source, 183 dB at a distance of 153 meters (502 feet) from the source, 187 dB at a distance of 83 meters (272 feet) from the source, and 206 dB at a distance of 3 meters (10 feet) from the source.

If any specific parameter of this ecological surrogate is exceeded, the anticipated incidental take levels are also exceeded, triggering the need to reinitiate consultation on the proposed DRS.

2.9.3 Effect of the Take

In the opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the sDPS green sturgeon or destruction or adverse modification of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon designated critical habitats.

2.9.4 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

NMFS has determined that the following RPMs are necessary and appropriate to minimize take of southern DPS of North American green sturgeon resulting from implementation of the proposed DRS.

1. Measures shall be taken to minimize the amount and duration of pile driving and its potential impacts on listed anadromous fish.

2. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

2.9.5 Terms and Conditions

The terms and conditions described below are non-discretionary, and the USFWS or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The USFWS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement RPM 1:

    a. The USFWS shall ensure that all in-water pile driving activity commences during a period of low tide each day.

    b. The USFWS shall notify NMFS if the amount and duration of the pile driving activities are determined to be insufficient to achieve the desired placement and depth below the channel bottom.

2. The following terms and conditions implement RPM 2:

    a. The USFWS shall provide an annual report summarizing construction activities, avoidance and/or minimization measures taken, the results of acoustic monitoring, and any observed incidents of take of listed species. These summary reports shall be submitted to NMFS, to the address below, by December 31 of each construction year.

    b. If a listed species is observed injured or killed by Project activities, the USFWS shall notify NMFS within 48 hours by calling the California Central Valley Office at (916) 930-3600. Notification shall include species identification, the number of fish, and a description of the activity that resulted in take. If possible, dead individuals shall be collected, placed in an airtight bag, and refrigerated with the aforementioned information until further direction is received from NMFS.

Updates and reports required by these terms and conditions shall be submitted to:

California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3600

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). Conservation recommendations also provide a direct opportunity to promote recovery plan actions and build Federal agency partnerships to implement them through section 7 of the ESA. Such partnerships could lead to programs that the Federal agencies recognize for conservation of listed species in furtherance of ESA section 7(a)(1). Recovery plan actions are discretionary and represent the best available information on what steps are likely to conserve the species. To encourage and facilitate their implementation, some of the conservation recommendations offered below include recovery plan actions from the *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead* (NMFS 2014). The specific conservation recommendations and recovery plan actions provided below were selected based on their appropriateness to either address or otherwise offset the anticipated effects of the action considered in this opinion, in addition to the USFWS' unique ability and capacity to implement these actions through the facility of the DRS once constructed and operational.

1. The USFWS should implement biotechnical techniques in place of traditional revetment techniques should any of the rock slope protection installed in conjunction with the proposed DRS begin to cause scour and require additional bank stabilization.

2. The USFWS should develop and implement a targeted research and monitoring program to better understand the behavior, movement, and survival of steelhead, spring-run Chinook salmon, and winter-run Chinook salmon emigrating through the Delta from the Sacramento and San Joaquin rivers.

3. The USFWS should facilitate the development of regional agreements on geographic boundaries for estimating through-Delta survival, and appropriate technologies for collecting the required empirical data.

4. The USFWS should develop and implement education and outreach programs to encourage river stewardship.

5. The USFWS should develop outreach strategies and mechanisms to ensure the Delta community, the legislature, appropriate agencies and the public are regularly updated on actions related to restoration and recovery.

6. The USFWS should coordinate efforts to identify and highlight funding needs for restoration planning, monitoring, tracking, synthesis and adaptive management in the near and long term.

7. The USFWS should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and sturgeon habitat restoration projects within the Delta region.

2.11 Reinitiation of Consultation

This concludes formal consultation for the proposed Delta Research Station project.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect" Determinations

Exposure of listed salmonids to the direct effects of the proposed DRS is expected to be entirely avoided largely because in-water work will occur during the summer and fall months when salmonids are not present in the action area. Long term, indirect effects are expected to result from impacts to habitat such as changes to the bathymetry or other structural components of the shoreline such as riparian shading or the removal of vegetation that may influence the extent of the forage base or the density of predator and prey species in the immediate area. A brief discussion of the likelihood of exposure of listed fish by month, species, and life stage follows:

For Sacramento River winter-run Chinook salmon, the proposed work window for DRS construction activities in the mainstem Sacramento River (July 1 through November 1) should preclude most, if not all, instances of exposure to the direct effects of the proposed DRS. Adult winter-run may begin to enter the action area in November, but are most likely to be present in the action area in December. Similarly, juveniles may be present in the action area as early as November and December, especially if significant rainfall events occur to trigger their outmigration behavior.

Adult Central Valley spring-run Chinook salmon are not expected to be present in the action area during the in-water work window from July 1 to November 1. Yearling fish may appear in the action area as early as late October, but are not likely to occur in any substantial numbers until after February when the bulk of yearling and young-of-year spring-run Chinook salmon begin to enter the Delta.

Adult CCV steelhead begin to migrate into the watersheds of the Central Valley during the late summer or early fall months (i.e., September through November), particularly when increased attractant flows are being released by upstream reservoirs to enhance fall-run Chinook salmon spawning runs or early winter rains create increased flows in the system. However NMFS does not expect them to be present in the action area in any significant numbers until the months of December through February, which is the peak of their spawning migration. The peak of juvenile CCV steelhead emigration from the tributaries in the Sacramento and San Joaquin river basins occurs from February through May. Therefore, conducting in-water construction activities from July 1 through November 1 should avoid impacts to the majority of out migrating juvenile steelhead smolts. There are larger steelhead smolts that migrate at other times of the year, including the fall and early winter period, that may be exposed to the direct effects of the action during their passage through the action area, albeit in very small numbers. As with adults, however, NMFS expects the most likely period for them to be present is during the month of December.

Based on the timing of salmonid movements in and through the action area described above, NMFS does not anticipate the proposed DRS will result in adverse effects to Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or California Central Valley steelhead. NMFS reached these conclusions based on the timing of the in-water work, and pile driving activity in particular, associated with the construction of the marina being limited to the period from July 1 to November 1 each year, during the time of year when Chinook salmon and CCV steelhead are not expected to be present in the action area. Furthermore, most of the disturbances to designated critical habitat in the action area are expected to be temporary in duration and limited in spatial extent to the area immediately adjacent to the RVARC. The removal of riparian vegetation and conversion of shallow water habitat to deeper water may contribute to temporary increases in predator interactions and/or reductions in the amount or quality of prey and refugia locally available within the action area, but relative to the size and extent of tidally-influenced waters immediately adjacent to and surrounding the action area, these potentially adverse effects are expected to be insignificant and will not diminish the overall conservation value of the designated critical habitat as rearing habitat or as a migratory corridor for any of the listed fish species considered in this opinion. Similarly, because of the planned protective protocols and effluent treatment methods previously described in section 1.3 (*Proposed Federal Action*), no adverse effects to listed anadromous fish species or their designated critical habitat are anticipated to occur as a result of degraded water quality associated with DRS operations and maintenance either.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

3.1 Essential Fish Habitat Affected by the Project

This analysis is based, in part, on the EFH assessment provided by the USFWS and descriptions of EFH within the Pacific Coast salmon fishery management plan (FMP, PFMC 2014) developed by the Pacific Fishery Management Council (Council) and approved by the Secretary of Commerce. The implementing regulations for the EFH provisions of the MSA (50 CFR 600.815(a)(8)) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs for Pacific Coast salmon: (1) complex channels and floodplain habitats, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation. With the exception of estuaries, none of these HAPCs have been comprehensively mapped, and some may vary in location and extent over time. It is important to note that HAPCs include all waters, substrates, and associated biological communities falling within the designated area. In some cases, HAPCs may overlap with each other (e.g., estuaries with marine and estuarine submerged aquatic vegetation), an indicator of the multiple habitat functions provided by, and the increased importance of, that area. It should also be noted that Pacific Coast salmon includes all runs, including fall-run and late fall-run Chinook salmon, and the analysis for winter-run and spring-run Chinook salmon presented in the preceding biological opinion applies to them as well.

The USFWS has determined that the proposed Project will adversely affect the EFH for federally managed fish species within the Pacific Coast salmon FMP, including the following HAPCs: (1) estuaries, defined as the upriver extent of saltwater intrusion where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow, and (2) marine and estuarine submerged aquatic vegetation.

3.2 Adverse Effects on Essential Fish Habitat

Excavation and dredging activities associated with the construction of the new marina associated with the DRS will result in the permanent conversion of 0.98 acres of shallow water habitat to deep water habitat and temporarily: (1) increase turbidity and the potential for exposure to contaminants released through the resuspension of bottom sediments, and (2) reduce prey availability locally in the action area. In addition, an increase in the shading of near shore habitat due to the presence of newly-installed structures like docks and piers is likely to diminish the overall quality of the habitat for rearing and migrating salmonids in the action area by decreasing the amount of riparian and submerged aquatic vegetation providing foraging and resting areas, protective cover from predators, and thermal refugia. Similarly, a concentration of the volume of anticipated routine small boat traffic associated with the operation of the marina is also likely to adversely affect EFH for Pacific salmon in the action area through many of the same mechanisms. Both HAPCs of estuaries, and marine and estuarine submerged aquatic vegetation, are likely to be impacted by these effects. As noted earlier, HAPCs for Pacific salmon apply to all runs of Chinook salmon, including fall-run and late fall-run, and the effects to EFH are similar to the effects to designated critical habitat for winter-run and spring-run Chinook salmon as described in the preceding biological opinion. None of these effects are anticipated to extend beyond the immediate locality of the marina, however; and as noted, many of the effects are expected to be temporary, with conditions quickly reverting to pre-construction conditions aside from the permanent conversion of 0.98 acres of shallow water habitat to deep water habitat and the loss of 0.48 acres of riparian vegetation. These effects have been analyzed and described in greater detail in Section 2.5 (*Effects of the Action*) of the preceding opinion.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS incorporates recommendation 1 from Section 2.10 (*Conservation Recommendations*) of the preceding opinion as a conservation recommendation that is appropriate and necessary to address the adverse effects to EFH described in Section 3.2, above.

Fully implementing these EFH conservation recommendations would offset impacts to approximately 1.46 acres of designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the USFWS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The USFWS must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

NMFS incorporates the conservation recommendations provided in section 2.10 (*Conservation Recommendations*) of the preceding biological opinion as applicable and consistent with the purposes of the FWCA.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA.

This concludes the FWCA portion of this consultation.

5. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Fish and Wildlife Service. Other interested users could include the California Department of Water Resources and the California Department of Fish and Wildlife. Individual copies of this opinion were provided to the USFWS. This opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts) under Consultation Number *2017-WCR-6715*. The format and naming adheres to conventional standards for style.

5.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

5.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion [*and EFH consultation, if applicable*] contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [*and MSA implementation, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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